

**Tatsuyoshi MORITA*: A search for diploid *Taraxacum*
in Korea and eastern China, by means of pollen
observations on herbarium specimens**

森田竜義*: 朝鮮及び中国東部におけるタンポポ属の
2倍体種の分布

Taraxacum, a widely distributed genus in temperate to arctic regions of mainly northern hemisphere, includes diploid with $2n=16$ chromosomes and a series of polyploids of $3X$, $4X$, $5X$, $6X$ and $8X$ ($X=8$). The polyploids, which are mostly obligate or partly facultative agamosperms, are predominant and widespread over the geographical range of the genus. On the other hand, the diploid entities being invariably sexual are rather rare and limited in range (Richards 1970, 1973). As the diploid sexuals are generally considered to be primitive forms, particular attention has been paid to their distribution and characteristics by several authors, who investigated the origin and evolutionary process of *Taraxacum* agamospecies (Förnkrantz 1960, Malecka 1967, Richards 1973, Sterk & Den Nijs 1978).

According to Richards (1970), most diploids are found in central Asia and a few occur in the Mediterranean area as well as in isolated localities in the rest of Europe; further they were also reported from Greenland and the Falkland Islands in South America. The occurrence of diploid *Taraxacum* in the Far East has not been paid great attention, although Richards (1970) mentioned that most Asian sections of *Taraxacum* contain diploid species. However, the author demonstrated a rather wide and continuous distribution of the diploids in the central parts of Japan (Morita 1976). In the remaining areas of the Far East, the diploids were reported only from Formosa (Okabe 1951, Peng 1976) and Isl. Quelpart (Lee 1970). However, chromosome counts from these areas as listed in Table 1 are too fragmentary to understand the cytogeography of the group as a whole.

As pointed out by a number of authors (Tschermak-Woess 1949, Förnkrantz

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1960, Richards 1970, Morita 1976 etc.), pollen features of diploid *Taraxacum* are quite different from those of the polyploids. Pollen grains of the diploids are normal, namely small and homogeneous in size, regular in exine structure and most of the grains are viable judging from their stainability. While, in the case of the polyploids, abnormal pollen grains are produced, which vary in size extremely even within the same anther and manifest various degrees of irregularity in exine structure. Further, the large amount of them are sterile with degenerate pollen contents.

These differences can be readily detected except for rather rare cases of facultative agamosperms with slightly abnormal pollen (Richards 1970), and pollen examinations on herbarium specimens were very useful in the

Table 1. Number of herbarium specimens of *Taraxacum* examined in this study, and of putative diploids and polyploids discerned by means of pollen observations.

Species name	Total	Diploid	Polyploid	Chromosome numbers reported
<i>T. coreanum</i> Nakai	65 (56)	0	65 (56)*	32: Okabe 1951. Lee 1970.
<i>T. erythropodium</i> Kitag.	6 (1)	0	6 (1)*	
<i>T. formosanum</i> Kitam.	53 (30)	17 (7)*	36 (23)	
<i>T. hallaisanense</i> Nakai	19 (5)	19 (5)*	0	16: Okabe 1951. Peng 1976. 24, 32: Yamaguchi 1974.
<i>T. heterolepis</i> Nakai et Koidz.	3 (3)	0	3 (3)*	16: Lee 1970.
<i>T. lamprolepis</i> Kitag.	5 (1)	0	5 (1)*	24: Gustafsson 1932. Lee 1970.*** 32: Battaglia 1948.
<i>T. latifolium</i> Kitam.	18 (10)	0	18 (10)*	
<i>T. mongolicum</i> Hand.-Mazz.	76 (41)	0	76 (41)	
<i>T. multisectum</i> Kitag.	8 (1)	0	8 (1)*	
<i>T. ohwianum</i> Kitam.	73 (47)**	16 (10)	55 (37)*	24: Okabe 1951.
<i>T. platyepidum</i> Diels	6 (5)	2 (2)	3 (3)	24: Yamaguchi 1976.
<i>T. sinicum</i> Kitag.	64 (36)	0	64 (36)*	24: Okabe 1951.
<i>Species undetermined</i>	49 (29)	0	49 (29)	

Numerals in parentheses denote the number of localities. *: The type specimen is included. **: Two specimens undetermined are included. See the text. ***: Under the name of *T. platycarpum* Dt.

geographical study on Japanese *Taraxacum* (Morita 1976). The present study attempts to find out the occurrence of the diploids in Korea and east parts of China by means of the same method.

Materials and Methods Specimens of Korean and Chinese *Taraxacum* preserved in the following Japanese herbaria were examined: TI (Department of Botany, University of Tokyo), KYO (Department of Botany, Kyoto University), TNS (National Science Museum, Tokyo), MAK (Makino Herbarium, Metropolitan University, Tokyo).

Pollen features of specimens were observed by staining pollen with cotton blue-lactophenol solution. The following three criteria were used in order to determine whether diploid or polyploid; (1) pollen size and its homogeneity, (2) stainability of pollen contents, (3) regularity in exine structure.

In this paper, the author has mainly followed taxonomic treatments of Kitamura (1957).

Results and Discussion

(1) Species including diploid.

A total of 445 herbarium specimens belonging to the 12 species as listed in Table 1, which were all collected from Korea and China were examined palynologically to determine whether diploid or polyploid. Their locations are shown in Fig. 1. Among them, most specimens had a feature of polyploid, while 54 collections listed in Appendix (p. 41) were diploid (12.1%). These putative diploids were included in the following four species, i.e., *Taraxacum formosanum* Kitamura, *T. hallaisanense* Nakai, *T. ohwianum* Kitam. and *T. platyepidum* Diels.

Taraxacum formosanum Kitam.: This species was first described from Formosa by Kitamura (1933) and Kitagawa reported its occurrence in north-eastern China (Kitagawa 1933). Later, the plants from continental China, Korea and south-western Japan were also referred to as *T. formosanum* by Kitamura (1957). Among the chromosome counts of $2n=16$ (2X), $24(3X)$, $32(4X)$ so far known for this species, the reports of diploid were made from Formosan materials, that is from Tanshui (a personal communication from Kitamura; in Okabe's report (1951), the locality was not given) and from Shimen (Peng 1976). Triploid and tetraploid were obtained from Isl. Tsushima and the Shimabara Peninsula, Kyushu in Japan (Yamaguchi 1974).

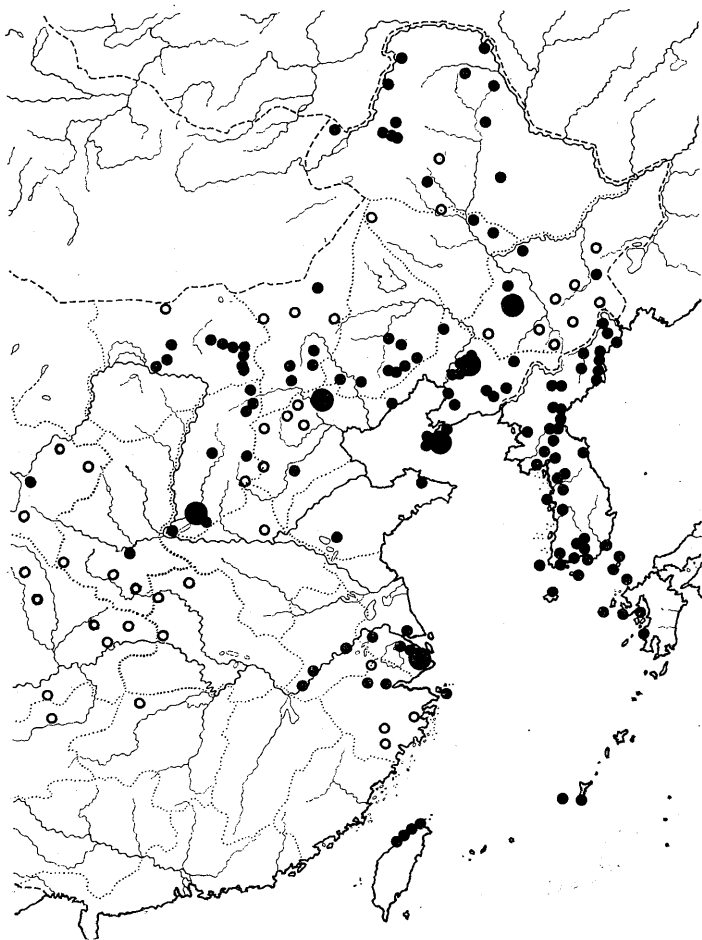


Fig. 1. Localities of the herbarium specimens of *Taraxacum* examined in the present study (filled circles). Large filled circles represent those of more than ten specimens examined. Open circles show unexamined localities based on the distribution map of *Taraxacum* in China (after Hu 1964).

In the present study, all specimens from Formosa including the type specimen were turned out to be diploid (15 specimens from six localities). On the other hand, specimens outside of Formosa were found to be polyploid, except for two collections from Shangfang-shan in continental China. These

results are well in agreement with the above-mentioned cytological reports.

The polyploid plants which have been referred to as this species show continuous variation in gross-morphology of involucre and achenes from *T. mongolicum* Handel-Mzt., all of which were polyploid as far as examined in this study (Table 1). Therefore, the taxonomic status of these two species needs to be revised.

Taraxacum hallaisanense Nakai: Lee (1970) reported this species to be diploid from the materials of Isl. Quelpart. The results of pollen examinations are in accord with his report, i. e., all specimens from Isl. Quelpart (11 specimens) as well as each one specimen from Suwon and Seoul cited in Kitamura (1957) were of diploid pollen features. There are two additional diploid specimens from Suwon (v. Appendix). Although one of them (*T. Sakata KYO*) was cited by Kitamura (1957) under the name of *T. ohwianum*, both can be regarded as *T. hallaisanense*. The diploids referable to this species were also found from Baechon and Munsan (each two specimens).

Taraxacum ohwianum Kitam.: The chromosome number of *T. ohwianum* is known to be $2n=24$ (Okabe 1951), although the source of materials is not given. The results of pollen examinations suggest the occurrence of diploid in this species as well, i. e., among 73 specimens examined, 17 from 11 localities showed diploid pollen features. With respect to two specimens (Hamhung, N. Nomura 4 *KYO* and Kosho, Nomura 9 *KYO*), determination was not possible because of their possession of no pollen. However, these two specimens may be diploid, since they are not distinguishable in gross-morphology from the diploid plants collected from the same localities. Their defective pollencytes without exine are small and uniform in size.

The main body of diploid specimens of *T. ohwianum* is from Hamkyongnamdo and Hamkyongpukdo in north-eastern Korea. Several other specimens with diploid pollen features were found from two localities in Liaoning, north-eastern China; six from Fenghuang-shan (cited in Kitagawa, 1933), and one from Jiguan-shan. The diploid plants of *T. ohwianum* seem to be somewhat different from the polyploids in their morphological characters such as involucre and achenes.

Taraxacum platypecidum Diels: Triploid chromosome number of $2n=24$ is known from Japanese materials (Yamaguchi 1976), but no report is available for Korean or Chinese plants. Pollen features indicating diploid were

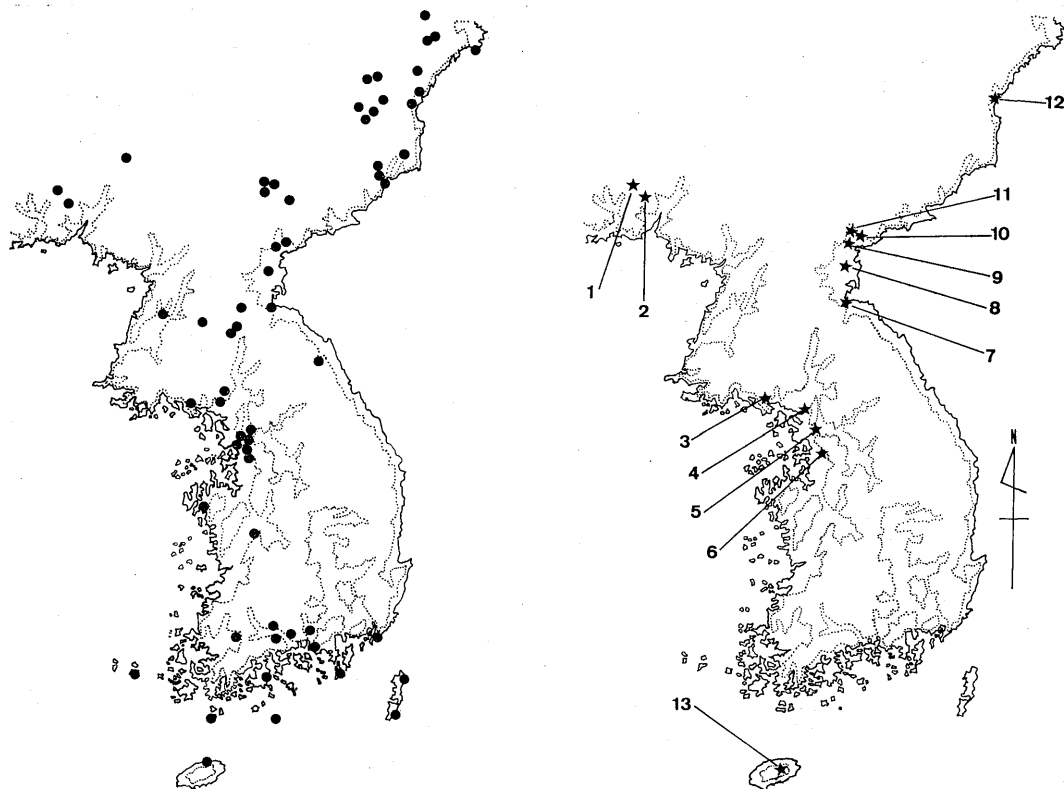


Fig. 2. Localities of diploid (right) and polyploid (left) *Taraxacum* in the Korean Peninsula and vicinity. The dotted lines show 200 m alt. above sea level. 1: Jiguan-shan. 2: Fenghuang-shan. 3: Baechon. 4: Munsan. 5: Seoul. 6: Suwon. 7: Wonsan. 8: Susangli. 9: Hamhung. 10: Kishuji. 11: Kosho. 12: Ranan. 13: Mt. Hanla-san in Isl, Quel-part.

observed in two specimens of *T. platyepidum* from Hamhung and Ranan in Korea, where the diploid plants of *T. ohwianum* were also collected.

(2) The geographical distribution of diploids in the Far East.

The above-mentioned results may be interpreted from a standpoint of geographical distribution as follows.

From the Korean Peninsula and its vicinities, 13 localities of diploid *Taraxacum* were found (Fig. 2). The diploids appear to have rather limited ranges of distribution as compared with those of the polyploids. The localities of *T. hallaisanense* are now known from the Island of Quelpart, and also from four localities in the vicinity of Seoul (3 to 6 in Fig. 2). Diploid plants of *T. ohwianum* show somewhat disjunct distributions, i.e., seven localities in Hamkyongnamdo (7 to 11 in Fig. 2; two other localities, Kakisen and Banryusan, could not be located in the map) and one somewhat isolated locality in Ranan on the eastern side of the Korean Peninsula, and two additional localities in Liaoning on the west. Diploid plants of *T. platyepidum* is known from two localities, Hamhung (9 in Fig. 2) and Ranan (12 in Fig. 2) on the eastern side.

The diploid *Taraxacum* including *T. hallaisanense* occurs mostly in the lowlands below 200 m above sea level in elevation, but in the Island of Quelpart *T. hallaisanense* was collected from mountain areas, some even from the altitudes exceeding 1000 m in elevation (K. Nakajima KYO).

Little is known about the habitat preference of Korean diploid *Taraxacum*, although the brief descriptions, e.g., such as "footpath between paddy fields" (Suwon, H. Ueki TI 11067) and "ground" (Hamhung, Nomura 45 KYO) are on the herbarium sheets. The information, though limited, may suggest that their habitats are similar to those of Japanese diploid *Taraxacum* species, which are growing in ruderal plant communities formed under rather mild, artificial disturbance such as periodical mowing. Although almost all specimens collected from continental China and now preserved in Japanese herbaria were examined in this study, only a single locality of diploid plants, i.e., Shangfang-shan, Suzhou was discovered (Fig. 4-1). According to Dr. H. Migo, one of the collectors of these specimens (personal communication), Shangfang-shan, about 50 m hill in elevation, which is located in an extensive delta plain of the Yangtze River, is covered by short herbs and shrubs.

In Formosa, the localities of the only native species *T. formosanum* are

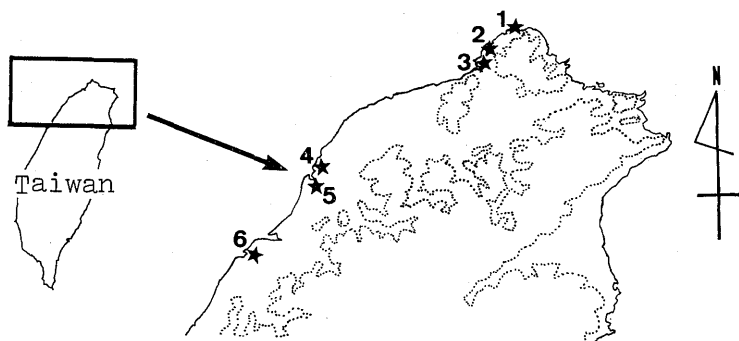


Fig. 3. Localities of examined specimens of *T. formosanum*. The dotted lines represent 200 m alt. above sea level. 1: Fukueichiao. 2: Huiyaozi. 3: Tanshui. 4: Shanjiao. 5: Hsinchu. 6: Tashanjiao.

restricted to the west side of northern districts (Fig. 3). It is noteworthy that only the diploid plants are distributed as natives in this island, which is located in the southernmost end of the distribution range of Asiatic *Taraxacum*. The habitats in Formosa seem to be sandy places in littoral regions (Kitamura 1933, Peng 1976).

Fig. 4 shows the distribution of diploid *Taraxacum* in the Far East. The distribution in the Japanese Islands and Isl. Kumejima (Fig. 4-3) is based on a previous report (Morita 1976). As shown here, a number of localities of diploid *Taraxacum* are known in the eastern part of the distribution range of the genus *Taraxacum* in Asia, covering the broad range from northern to south-western parts of the Japanese Islands and also Formosa, and in addition several isolated localities in the eastern edge of the continent. As stated above, 12.1% of specimens examined in this study were diploid. This figure is similar to average percentage (14%) of world-wide distribution of diploid species in *Taraxacum* estimated by Richards (1970), but is far lower as compared with 51% in Japan (Morita 1976). This fact suggests that diploid *Taraxacum* in this area is particularly concentrated in the Island of Japan.

Malecka (1967) indicated that diploid *Taraxacum* species in central Europe and in the Peary Land of Greenland are relicts remaining in areas which

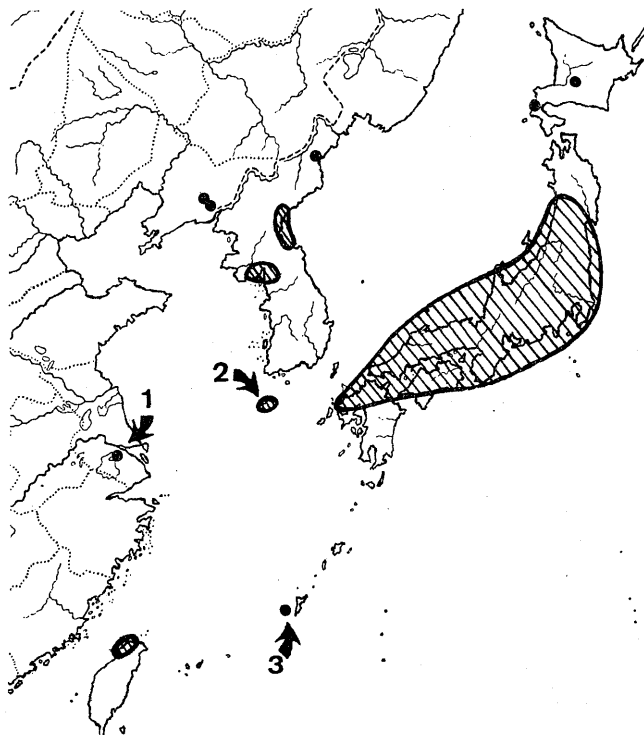


Fig. 4. Geographical distribution of diploid *Taraxacum* in eastern Asia (dots and hatched areas). 1: Shangfang-shan. 2: Isl. Quelpart. 3: Isl. Kumejima.

were free of the ice-sheet or corresponded to glacial refuges. Also in the Far East, ranges of diploid *Taraxacum* are just confined to the areas of refuges of tertiary elements during the Würm Ice Age (de Lattin 1967).

I wish to thank Prof. Takashi Yamazaki, University of Tokyo, for his kind guidance during the course of this study, Prof. Shoichi Kawano, Toyama University, for critically reading the manuscript. Thanks are also due to the curators of the herbaria mentioned above.

Appendix: List of specimens determined to be diploid.

Korea: **Quelpart**: Mt. Hanlasan, 10 May 1913, T. Nakai (TI)**—type

specimen of *T. hallaisnense* Nakai. *ibid.*, 10 May 1913, T. Nakai (TI)**. *ibid.*, 14 July 1966, T. B. Lee & M. Y. Cho (TI). *ibid.*, 9 May 1938, K. Cho (TNS). *ibid.*, 5 Aug. 1933, M. Boku (KYO)**. *ibid.*, 1200 m alt., 6 Aug. 1936, K. Nakajima (KYO)**. Kannonji, 5 Aug. 1936, K. Nakajima (KYO)**. Sukipo (西帰浦), 23 Apr. 1932, K. Katakura (KYO)**. Isl. Quelpart, May 1935, J. Ohwi 9393 (KYO)**. *ibid.*, June 1907, E. Taquet 244 (KYO)**. **Prov. Kyonggido** (京畿道): Suwon (水原), 28 Apr. 1912, H. Ueki (TI). *ibid.*, Kwasan (花山), 17 Apr. 1932, T. Sakata (KYO)**. *ibid.*, Chilbosan (七宝山), 27 Apr. 1932, T. Sakata (KYO)*. Seoul (京城), 6 May 1936, M. Boku (KYO)**. Munsan (汶山), 21 Apr. 1938, M. Boku 845 (KYO). *ibid.*, 24 Apr. 1938, M. Boku 844 (KYO). **Prov. Whanghaenamdo** (黄海南道): Baechon (白川), 5 May 1940, collector unknown (TNS 64421). *ibid.*, 6 May 1940, R. Cho (TNS 64426). **Prov. Hamkyongnamdo** (咸鏡南道): Hamhung (咸興), Apr. 1933, N. Nomura (N. N. here after, KYO)*. *ibid.*, 6 May 1934, N. N. 45 (KYO). Banryusan, Apr. 1938, N. N. (KYO)*. Kosho, 5 May 1935, N. N. 7 (KYO)****. *ibid.*, 5 May 1938, N. N. 8 (KYO)*. Kishuji (帰州寺), 9 May 1935, N. N. (KYO)*. Kakisen, 28 Apr. 1935, N. N. 10 (KYO). Susangli (西上里), 21 Apr. 1935, N. N. (KYO)*. Wonsan (元山), 21 Apr. 1935, S. Yamagishi (KYO). **Prov. Hamkyongpukdo** (咸鏡北道): Ranan (羅南), May 1935, T. Saito 903 (KYO)****. *ibid.*, Rananjinja shrin 25 Apr. 1934, T. Saito (KYO)*.

China: **Kiangsu**: Suzhou, Shangfang-shan (上方山), 5 Apr. 1935, H. Migo (KYO). *ibid.*, 5 Apr. 1935, K. Kimura (KYO). **Liaoning**: Jiguan-shan (鷄冠山), 5 May 1929, J. Sato (KYO). Fenghuang-shan (鳳凰山), 1 May 1932, M. Kitagawa (TI 15005, 15006, 15009-15012)—cited in Kitagawa (1933). **Formosa**: **Prov. Taipei**: Tanshui (淡水), Jan. 1932, S. Kitamura (KYO)***—type specimen of *T. formosanum* Kitam. *ibid.*, 20 Apr. 1932, S. Nagasawa (KYO)***. *ibid.*, 20 Apr. 1932, T. Tanaka & Y. Shimada (TI). *ibid.*, 15 Apr. 1938, G. Masamune (TNS). Fukueichiao (富貴角), 21 Jan. 1932, S. Kitamura (TI). *ibid.*, Jan. 1932, S. Kitamura (KYO)***. Huiyaozi (灰礪子), 18 Apr. 1937, Y. Shimada (TNS). **Prov. Hsinchu** (新竹省): Shanjiao (山脚), 30 Dec. 1929, collector unknown (TNS). Hsinchu, 25 Nov. 1896, T. Makino (TI)***. Houlung (後竜), Tashan jiao (大山脚), 15 Mar. 1931, Y. Shimada (KYO)***.

Asterisks show the citation in Kitamura (1957); *: *Taraxacum ohwianum*, **: *T. hallaisanense*, ***: *T. formosanum*, ****: *T. platyepidum*.

References

- Battaglia, E., 1948. Ricerche sulla parameiosi restituzionale nel genere *Taraxacum*. *Caryologia* 1: 1-47. de Lattin, G., 1967. Grundriss der Zoogeographie. Gustav Fischer. Fürnkranz, D., 1960. Cytogenetische Untersuchungen an *Taraxacum* im Raume von Wien. *Österr. Bot. Zeitschr.* 107: 310-350. Gustafsson, Å., 1932. Zytologische und experimentelle Studien in der gattung *Taraxacum*. *Hereditas* 16: 41-62. Hu, S. Y., 1964. The Compositae of China. *Quart. Journ. Taiwan Mus.* 18: 1-85. Kitagawa, M., 1933. Contributio ad Cognitionem Florae Manshuricae 1. *Bot. Mag. Tokyo* 47: 823-841. Kitamura, S., 1933. Compositae Novae Japonicae 4. *Acta Phytot. Geobot.* 2: 37-51. —, 1957. Compositae Japonicae, pars sexta. *Mem. Coll. Sci. Univ. Kyoto ser. B*, 24: 1-42. Lee, Y. N., 1970. Chromosome number of flowering plants in Korea 3. *Jour. Kor. Res. Inst. Ewha Woman Univ.* 5: 127-129. Malecka, J., 1967. Processes of intraspecific differentiation in the genus *Taraxacum*. *Genet. Polonica* 8: 185-188. Morita, T., 1976. Geographical distribution of diploid and polyploid *Taraxacum* in Japan (in Japanese). *Bull. Natn. Sci. Mus., Ser. B*, 2: 23-38. Okabe, S., 1951. On the chromosome numbers in asiatic species of *Taraxacum* (in Japanese). The coordinating Committee for Research in Genetics 2: 3-6. Peng, C. I., 1976. Systematic studies on Taiwan Compositae with a chromosome count. Master Thesis, Nat. Taiwan Univ. Richards, A. J., 1970. Eutriploid facultative agamospermy in *Taraxacum*. *New phytol.* 69: 761-774. —, 1973. The origin of *Taraxacum* agamospecies. *Bot. J. Linn. Soc.* 66: 189-211. Sterk, A. A. & J. C. M. den Nijs, 1978. Classificatie en sexualiteit bij *Taraxacum*. *Overdruk uit Gorteria* 9: 178-188. Tschermak-Woess, E., 1949. Diploides *Taraxacum vulgale* in Wien und Niederösterreich. *Österr. Bot. Zeitschr.* 96: 56-63. Yamaguchi, S., 1974. Karyotype analysis in Japanese *Taraxacum*. — Polyploidy in *T. formosanum* Kitamura (in Japanese). *La Kuromosomo* 98: 3058-3062. —, 1976. Chromosome numbers of Japanese *Taraxacum* species. *Journ. Jap. Bot.* 51: 52-58.

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花粉の性質の組違を利用して、腊葉標本から中国東部及び朝鮮におけるタンポポ属 2 倍体の分布を調べた。445 点の標本のうち 2 倍体は 54 点のみで、日本列島の場合に比

べてはるかに低い割合であった。それらはタカサゴタンボポ, イワタンボポ, コウライタンボポ, オダサムタンボポに含まれる。2 倍体の地理的分布をみると, 既に $2n=16$ の染色体数が報告されている済州島, 台湾の外, 朝鮮半島で初めて京城周辺及び咸興周辺に狭い分布域が確認された。中国では, 朝鮮に近い遼寧省の鳳凰山と鶏冠山で 2 倍体を確認されたが, 他の地域では蘇州上方山のみであった。

□KITAGAWA, M.: *Neo-lineamenta florum Manshuricae*. 715 pp. 1979. J. Cramer, Vaduz. ¥ ca. 32,000. 本書は北川政夫博士が1939年に出版された *Lineamenta florum Manshuricae* (満洲国植物考) の改訂版ともいふべきもので, 内容は前著とほぼ同じ形式をとって書かれている。北川博士が満洲で自ら採集した標本に基いて追加訂正されたものが多く, 所々に著者の新見解が見られ新学名もふくまれている。また最近のソ聯・中国などの研究をとりいれた改訂も行われている。この地域の植物を調べる上に不可欠な大変便利な書である。また日本植物に関連のある新見解も見られ, ムラサキモモンヅルに対し学名の新組合せが発表されている。ただ残念なことには北川博士が苦心して集められ本書の基礎となった資料は戦禍により失われてしまっている。本書は Tüxen 教授の斡旋によって同氏の *Flora et Vegetatio Mundi Band IV* として出版されたが, そのため色々の都合があつて著者にとって不十分な点もあつたようで, 6 ページに及ぶ正誤追加表が作られ, また今後更に訂正される意向とかがつている。 (原 寛)

本書はわが国の植物研究者の外地フロラ研究の成果として, 既に古典の一つにかぞえられる *Lineamenta Florae Manshuricae* の改訂版である。敗戦ですべてを失い, 身一つで帰国した著者が, 国内各地に保存されている標本と文献にもとづいて, 全体にわたって書き改め追補したもので, これから, 大陸のフロラと関り合いが多くなるこの時期に, 歓迎される文献である。はじめ12頁にわたって満州フロラの概説がなされ, 残り673頁は分類順のリストとなっており, 多くの異名, 和名, 分布, ノートが記されている。概してタクソンは小さ目な感じがする。新種の発表は本書ではなされていない。その代り, 主に種内のタクソンで, 非常に多くの新組合せがなされており, その数は239におよぶ。また新和名の発表も278に達している。これらの中には日本産植物に関するものも少なくない。例えばボウフウの学名が *Saposhnikovia seseloides* となった。*Ligularia* subsect. *Cyanocephalum* の中に, ser. *Epapposae* という系が新設されている。この他に *Polygonatum quinquefolium* (ヒナヨウラク), *Sedum Yamatsutae* (コバノキリンソウ), *Viola Yamatsutai* (マンシュウヒカゲスミレ), *Vicia unijuga* var. *breviramea* (エダウチナンテンハギ) の記載文が追補され, マンシュウヒカゲスミレと, エダウチナンテンハギのタイプ標本の指定がなされている。索引は属名についてのものがあるが, たくさん出て来る種以下の学名や, 和名の索引がないのは不便である。 (金井弘夫)